

AMENDMENTS TO THE CLAIMS

IN THE CLAIMS:

1. (Currently Amended) A ~~reflective~~-liquid crystal display ~~deviceem-device,~~ device, comprising:

a liquid crystal layer sandwiched between a first substrate having a light reflectibility and a second substrate having a light transmissibility, the liquid crystal layer including twist-aligned nematic liquid crystal having a ~~positive~~-dielectric anisotropy; and

a circularly polarizing unit, including a single linear polarizer plate that selectively passes either right handed or left handed circularly polarized light out of natural light,

wherein, the first substrate, the liquid crystal layer, and the circularly polarizing ~~means~~-unit are stacked in this order to form at least a part of the ~~reflective~~-liquid crystal display device,

the circularly polarizing unit is disposed such that a major surface of the circularly polarizing unit is on a liquid crystal layer side, the circularly polarized light exiting the circularly polarizing unit through the major surface when natural light enters the circularly polarizing unit,

a liquid crystal in the liquid crystal layer has a birefringence difference, which, if multiplied by a thickness of

the liquid crystal layer, produces a product of not less than 85nm and not more than 315nm, and

the liquid crystal layer has a twist angle in a range of 0° to 100°.

2. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in claim 1, wherein

the circularly polarizing unit includes,

a first optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 100nm and not more than 180nm, and

a second optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 200nm and not more than 360nm,

~~the linear polarizer plate,~~ the first optical retardation compensator plate, the second optical retardation compensator plate, and the linear polarizer plate being stacked in this order when viewed from the liquid crystal layer, and

$|2\theta_2 - \theta_1|$ has a value not less than 35° and not more than 55° where θ_1 represents an angle formed by a slow axis of the first optical retardation compensator plate and either a transmission axis or an absorption axis of the linear polarizer plate, and θ_2 represents an angle formed by a slow axis of the second optical

retardation compensator plate and either the transmission axis or the absorption axis of the linear polarizer plate.

3. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in claim 2, wherein

the twist angle of the liquid crystal layer is in a range of 60° to 100° ,

the product of the birefringence difference of the liquid crystal in the liquid crystal layer and the thickness of the liquid crystal layer is not less than 250nm and not more than 330nm, and

either the transmission axis or the absorption axis of the linear polarizer plate forms an angle, θ_3 , of not less than 20° and not more than 70° , or not less than 110° and not more than 150° with an alignment direction of the liquid crystal molecules in a close proximity of the second substrate.

4. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a liquid crystal layer sandwiched between a first substrate having a light ~~reflexibility~~-reflectibility and a second substrate having a light transmissibility, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having a ~~positive~~ dielectric anisotropy; and

a circularly polarizing unit, including a single linear polarizer plate, that selectively passes either right handed or left handed circularly polarized light out of natural light,

wherein, the first substrate, the liquid crystal layer, and the circularly polarizing unit are stacked in this order to form at least a part of the ~~reflective~~-liquid crystal display device,

the circularly polarizing unit is disposed such that a major surface of the circularly polarizing unit is on a liquid crystal layer side, the circularly polarized light exiting the circularly polarizing unit through the major surface when natural light enters the circularly polarizing unit,

a liquid crystal in the liquid crystal layer has a birefringence difference, which, if multiplied by a thickness of the liquid crystal layer, produces a product of not less than 90nm and not more than 350nm, and

the liquid crystal layer has a twist angle in a range of 0° to 100° .

5. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in claim 4, wherein

the circularly polarizing unit includes,

a first optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 100nm and not more than 180nm, and

a second optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 200nm and not more than 360nm, and

~~a linear polarizer plate,~~ the first optical retardation compensator plate, the second optical retardation compensator plate, and the linear polarizer plate being stacked in this order when viewed from the liquid crystal layer, and

$|2\theta_2 - \theta_1|$ has a value not less than 35° and not more than 55° , where θ_1 represents an angle formed by a slow axis of the first optical retardation compensator plate and either a transmission axis or an absorption axis of the linear polarizer plate, and θ_2 represents an angle formed by a slow axis of the second optical retardation compensator plate and either the transmission axis or the absorption axis of the linear polarizer plate.

6. (Currently Amended) The ~~reflective~~ liquid crystal display device as set forth in claim 5, wherein

the twist angle of the liquid crystal layer is in a range of 60° to 100° ,

the product of the birefringence difference of the liquid crystal in the liquid crystal layer and the thickness of the liquid crystal layer is not less than 250nm and not more than 330nm, and

either the transmission axis or the absorption axis of the linear polarizer plate forms an angle, θ_3 , of not less than 20° and

not more than 70° , or not less than 110° and not more than 150° with an alignment direction of the liquid crystal molecules in a close proximity of the second substrate.

7. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy,

a twist angle in a range of about 0° to 10° , and

a birefringence difference, which for twist angle in the range of about 0° to 5° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 90 nm and not more than ~~185~~about 188 nm, or not less than ~~385~~about 382 nm and not more than ~~450~~about 451 nm, and which for twist angle in the range of about 5° to 10° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 90 nm and not more than about 188 nm, or not less than about 380 nm and not more than about 451 nm—and

~~— a twist angle in a range of 0° to 10° ; and~~

a circular polarizing unit that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

8. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy,

a twist angle in a range of about 10° to 20°, and

a birefringence difference, which for a twist angle in a range of about 10° to 15° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than ~~95~~about 90 nm and not more than about 190 nm, or not less than ~~380~~about 378 nm and not more than ~~445~~about 450 nm, and which for a twist angle in a range of about 15° to 20° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 90 nm and not more than about 192 nm, or not less than about 372 nm and not more than about 448 nm and ~~———— a twist angle in a range of 10° to 20° ; and~~

a circular polarizing unit that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said

plurality of wave lengths of said natural light to thereby create a display.

9. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy,

a twist angle in a range of about 20° to 30°, and

a birefringence difference, which for a twist angle in a range of about 20° to 25° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than 100 about 92 nm and not more than 190 about 195 nm, or not less than 370 about 365 nm and not more than 440 about 448 nm, and which for a twist angle in a range of about 25° to 30° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 95 nm and not more than about 202 nm, or not less than about 356 nm and not more than about 445 nm—and
~~———— a twist angle in a range of 20° to 30°; and~~

a circular polarizing unit that selectively passes either right handed or left handed substantially circularly polarized

light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

10. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy,

a twist angle in a range of about 30° to 45°, and

a birefringence difference, which for a twist angle in a range of about 30° to 35° if multiplied by a thickness of the liquid

crystal layer produces a product in the range of not less than ~~100~~about 98 nm and not more than ~~205~~about 210 nm, or not less than ~~345~~about 341 nm and not more than ~~430~~about 441 nm, which for a twist angle in a range of about 35° to 40° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 98 nm and not more than about 220 nm, or not less than about 323 nm and not more than about 437 nm, and which for a twist angle in a range of about 40° to 45° if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than about 100 nm and not more than about 240 nm, or not less than about 300 nm and not more than about 432 nm and

~~———— a twist angle in a range of 30° to 45°; and~~

a circular polarizing unit that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

11. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in any one of claims 7, 8, 9 and 10, wherein the first substrate having a light reflectibility includes a light reflective film, and

the light reflective film has smooth and continuously changing concavities and convexities, and is made of a conductive material.

12. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in any one of claims 7, 8, 9 and 10, further comprising:

one of an optical retardation compensator unit and a plurality of optical retardation compensator units provided between the circular polarizing unit and the liquid crystal layer to minimize influence from a residual phase difference of the liquid crystal layer.

13. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in any one of claims 7, 8, 9 and 10, wherein

the circular polarizing unit performs as an optical retardation compensator that minimizes influence from a residual phase difference of the liquid crystal layer during application of a voltage to the liquid crystal layer.

14. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in any one of claims 7, 8, 9 and 10, wherein the circular polarizing unit includes,

a first optical retardation compensator plate,

a second optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 200 nm and not more than 360 nm, and

a linear polarizer plate, and

wherein, $|2\theta_2 - \theta_1|$ has a value not less than 35° and not more than 55° , where θ_1 represents an angle formed by a slow axis of the first optical retardation compensator plate and either a transmission axis or an absorption axis of the linear polarizer plate, and θ_2 represents an angle formed by a slow axis of the second optical retardation compensator plate and either the transmission axis or the absorption axis of the linear polarizer plate,

a direction of the slow axis of the first optical retardation compensator plate is parallel to an alignment direction of a liquid

crystal in a middle of the liquid crystal later in a thickness direction, and

a retardation in the substrate normal direction of the first optical retardation compensator plate is set to a retardation that is smaller, by 10 nm to 50 nm, than a retardation for not less than 100 nm and not more than 180 nm that provides, across an entire visible range, a phase difference equivalent to a quarter wavelength.

15. (Currently Amended) The ~~reflective~~-liquid crystal display device as set forth in any one of claims 7, 8, 9 and 10, wherein the circular polarizing unit includes,

a first optical retardation compensator plate,

a second optical retardation compensator plate having a retardation in a substrate normal direction set to not less than 200 nm and not more than 360 nm, and

a linear polarizer plate, and

wherein, $|2\theta_2 - \theta_1|$ has a value not less than 35° and not more than 55° , where θ_1 represents an angle formed by a slow axis of the first optical retardation compensator plate and either a transmission axis or an absorption axis of the linear polarizer plate, and θ_2 represents an angle formed by a slow axis of the second optical retardation compensator plate and either the

transmission axis or the absorption axis of the linear polarizer plate,

the slow axis of the first optical retardation compensator plate is orthogonal to an alignment direction of a liquid crystal in a middle of the liquid crystal ~~later~~layer in a thickness direction, and

a retardation in the substrate normal direction of the first optical retardation compensator plate is set to a retardation that is greater, by 10 nm to 50 nm, than a retardation for not less than 100 nm and not more than 180 nm that provides, across an entire visible range, a phase difference equivalent to a quarter wavelength.

16. (Currently Amended) A ~~reflective~~ liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~ dielectric anisotropy,

a birefringence difference, which if multiplied by a thickness of the liquid crystal layer produces a product in the

range of not less than 100 nm and not more than 185 nm, or not less than 385 nm and not more than 430 nm, and

a twist angle in a range of 0° to 45°; and

a circular polarizing unit, including a single linear polarizer plate, that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

17. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy,

a birefringence difference, which if multiplied by a thickness of the liquid crystal layer produces a product in the range of not less than 95 nm and not more than 125 nm, and

a twist angle in a range of 0° to 45° ; and

a circular polarizing unit, including a single linear polarizer plate, that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

18. (Currently Amended) A ~~reflective~~-liquid crystal display device, comprising:

a first substrate having a light reflectibility;

a second substrate having a light transmissibility;

a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having,

a ~~positive~~-dielectric anisotropy, and

a birefringence difference Δn , a thickness of the liquid crystal layer d , and a twist angle ϕ_{tw} in the range of 0° to 45° , such that the value of the function

$$f_{vis} = k \int_{380}^{780} \bar{y}(\lambda) S_{D65}(\lambda) f(\lambda) d\lambda$$

is 0.7 or higher, where

$$k = 1 / \int_{380}^{780} \bar{y}(\lambda) S_{D65}(\lambda) d\lambda$$

$\bar{y}(\lambda)$ is the visual sensitivity curve of the color matching function of CIE1931,

$S_{D65}(\lambda)$ is the spectrum density of a D_{65} standard light source,

$$f(\lambda) = 1 - \left\{ 1 - 2\phi_{ret}^2 (\sin c \sqrt{\phi_{ret}^2 + \phi_{tw}^2})^2 \right\}^2$$

$$\phi_{ret} = \pi \frac{\Delta n d}{\lambda} \quad \text{and}$$

$$\sin c X = \frac{\sin X}{X} \quad ; \text{ and}$$

a circular polarizing unit, including a single linear polarizer plate, that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.

19. (Currently Amended) A ~~reflective~~ liquid crystal display device, comprising:

- a first substrate having a light reflectibility;
- a second substrate having a light transmissibility;
- a liquid crystal layer sandwiched between the first substrate and the second substrate, the liquid crystal layer being composed of twist-aligned nematic liquid crystal having a ~~positive~~

dielectric anisotropy and a twist angle in a range of 0° to 45° ;
and

a circular polarizing unit that selectively passes either right handed or left handed substantially circularly polarized light out of a plurality of wavelengths of natural light in the visible spectrum,

wherein, the circular polarizing unit is disposed such that a major surface of the circular polarizing unit is on a liquid crystal layer side, the substantially circularly polarized light exiting the circular polarizing unit through the major surface when natural light enters the circular polarizing unit, and

wherein, said incoming substantially circularly polarized light being linearly polarized at a surface of said first substrate in a plurality of directions respectively representative of said plurality of wave lengths of said natural light to thereby create a display.